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Influence of heat treatment on Vitamin C Levels in Oyster Mushroom

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ABSTRACT : *The study was conducted to investigate the influence of heat treatment during drying process of Oyster mushroom in the tropics. Mushroom growing is carried out under carefully controlled conditions mostly in bulk in specific designed tunnels with aerated floors. There are two main purposes, firstly pasteurization; to free the compost from undesirable microbes and pests and secondly conditioning; to become mushroom specific by getting clear of ammonia and free of readily available carbohydrates. Through proper manipulation of temperature and ventilation these two primary objectives are accomplished. Mushrooms have been identified as an underutilized crop in Africa, with many nutritive and health benefits. It does not require much land and investment. However, it is highly perishable and there is need to process it to lengthen its shelf life by drying. However, there is need to ensure that the nutrients are not lost in the process. It is for this reason that this project investigated the effect of drying on nutrient levels in mushroom. Vitamin C levels were monitored in the course of drying at 80ºC, 60ºC, 50ºC, 40ºC and in direct sunlight. It was concluded that the temperature that gave the best drying rate with minimal nutrient loss was 60ºC. In general, more than half the Vitamin C is lost during the range of drying temperatures investigated.*

KEYWORDS: *Fungi, drying, temperature, nutrient level, moisture content, oxidation*

I. INTRODUCTION

Mushrooms are the fruiting bodies of *Pleurotus ostreatus* macro fungi. There are edible, medicinal and poisonous species and have over the years been in use by most people in the world as a source of food and medicine. The gap in knowledge has its negative effects on the processing of mushrooms which is an important source of nutrients. Major processes in mushroom handling such as growing and postharvest handling have not yet been explored. Although people have been drying mushrooms for thousands of years, the methods that have been used have a small potential to meet the current nutritional and food reserve demand. People today still employ the same technique and technology to dry mushrooms that those early peoples did: the sun and air. However, there are several advances in mushroom-drying technology extending to both commercial and home drying that need to be explored [1]

Mushrooms are highly nutritious. The protein content is of mushroom is estimated to be 3.5 to 4.0% on a wet basis and 19 -35 % on a dry basis. In comparison, the protein content of common meats is as follows: pork, 9-16 %; beef, 12-20 %; chicken, 18-20 %; fish, 18 -20 %; and milk, 2.9- 3.3 % on wet basis. Furthermore, mushroom protein contains all the nine essential amino acids required by man. They are also a relatively good source of fat, phosphorus, iron, and vitamins including thiamine, riboflavin, ascorbic acid, *ergosterine* and *niacin*. They are low in calories, carbohydrates and calcium [4].

A.

Mushrooms have very good anti-tumour and anti-cancer effects since they produce several biologically active compounds, notably, a group of polysaccharides comprising high molecular weight sugar polymers has been reported to contribute to their immune enhancing and tumour retarding effects [3], [10].

Quality deterioration takes place if fresh mushrooms are not immediately processed. Under ideal climatic conditions, shelf life of these mushrooms varies, their quality being affected predominantly by storage temperature. The shelf life can be reduced from 9 days at 2ºC to 3 days at 18 ºC. There is need to quickly process mushroom into stable forms to prevent spoilage. The common methods used in processing and preservation of mushroom include drying, freezing, canning and pickling [7].

For tropical countries, drying is normally a viable option due to the abundant solar energy that reduces costs significantly. Dehydrated mushrooms are used as an important ingredient in several food formulations including instant soups, pasta salads, snack seasonings, stuffing, casseroles, and meat and rice dishes. Dehydration is a classical method of food conservation, based on the principle that the reduction of the water activity of the product must be conducted until defined levels that guarantee the microbiological and physicochemical stability [5], [6].

For long periods of conservation, the traditionally used method for mushrooms is the convective drying at 45-65ºC. Drying reduces bulk quantity, thus facilitating transportation, handling and storage. Although the conventional sun-drying is economical, mechanical drying speeds up the process, prevents losses, ensures use of safer drying temperatures and produces superior product compared to sun drying [1], [12], [13].

All mushroom drying technologies and methods aim to accomplish the same thing that is to reduce moisture in the mushroom, which stops bacteria and mould from growing and ruining the mushrooms. The mushrooms should be dried fast enough to prevent bacteria and mould growth but proper care must be taken not to cook the mushrooms especially when using a technique that presents such a risk, like oven drying. Mushrooms must be stored in an airtight container to avoid moisture formation. A silica gel packet helps keep them dry [1]

Apart from cooking, burning the mushroom and altering its flavour during the drying process, there is an ever present danger of loss of nutritive value as a consequence of the drying process. It was a major objective of this study to determine the effect of drying at different temperatures on the level of nutrients in the dried mushroom. The relationship between drying and nutrient retention in mushroom is not well documented. Since Vitamin C is more volatile than other nutrients and tracking levels of it at different drying temperatures would be a good indication of the status of the other nutrients, hence reference to it in this project.

Heating can be both beneficial and detrimental to nutrient content of foods. There are two processes occurring during drying, the addition of heat and the removal of moisture from the food. Nutritional losses during drying are more due to the application of heat than to the removal of moisture. Nutrient losses during the drying process depend on:

- preparation procedures before drying, e.g. slicing, blanching
- drying temperature
- drying time
- storage conditions [2].

The objective of the study was to determine the relationship between the drying temperature of oyster mushroom and the level of nutrients during drying.

II. MATERIALS AND METHODS

Fresh Oyster mushroom samples were used in the experiments. The following properties were determined:
1)

A. Moisture content

The moisture content (m.c.) of the fresh mushroom was determined by heating a known mass of mushroom in an oven at 105 ºC for 48 hours (gravimetric method). The moisture content was calculated using equation 2.1.

$$mc(wb) = \frac{(mi - mf)}{mi} \quad (1)$$

Where:

mc (wb) = Moisture content on wet basis
mi = Initial mass
mf = Final mass

B Drying Experiments: The mushrooms were oven dried at 40, 50, 60 and 80 ºC. Other samples were sun dried. The change in mass was recorded over time until constant mass was attained. From this data the change of

moisture content was determined. Daily data on weather conditions during the sun drying experiment was also collected from the meteorological department on daily temperature and relative humidity. Curves of drying rate were plotted.

C Determination of levels of Vitamin C : The effect of heat on the nutritional content of mushrooms was investigated by analyzing the nutritional quality of oven dried mushrooms when different drying temperatures are used. This was done by investigating the content levels of the volatile vitamin C (ascorbic acid) in mushroom samples dried at different temperatures. It was assumed that other nutrients (proteins, vitamins, carbohydrates and minerals) are affected by relatively higher temperatures than vitamin C and therefore vitamin C content of mushrooms dried at different temperatures would indicate the threshold temperature at which the mushrooms can be dried without causing excessive loss of nutrients.

The method used to determine the vitamin C content of mushrooms dried at different temperatures was method No. 44 of International Federation of Fruit Juice Producers, 1972. Vitamin C was extracted from a known mass of each mushroom sample using a known amount of trichloroacetic acid (TCA). The samples considered included: Fresh mushroom sample, sun dried sample, oven dried samples at a temperature of 40, 50, 60, 80 and 105 ºC.

The extract for each sample was filtered using a filter paper. Drops of starch indicator were then added. Thereafter 5 ml of the 4% KI solution was added to 5ml of the filtrate and then titrated with 1mg/l N-bromsuccinimide solution. Dark green colour indicated the end point. The volume of N-bromsuccinimide solution used to trigger colour change was read from the burette and recorded. Equation 2.2 was used to determine the vitamin C content.

$$Vita\min C(mg) = \frac{V \times C \times 176}{178} \tag{2}$$

Where:

V = Volume of the N-bromsuccinimide solution (ml)
C = Concentration of the N-bromsuccinimide solution (mg/l)

The procedure was repeated with every mushroom sample considered. The maximum temperature to adversely reduce the vitamin C was identified and used as the threshold drying temperature.

III. RESULTS AND ANALYSIS

Moisture content of mushrooms: The initial moisture content obtained for the oyster mushrooms was 91.4 % (w.b) which was similar to that found by [8]. This moisture content is high similar to most agricultural products such as tomatoes with a moisture content of 95% (w.b) and mangoes at 85% (w.b). From the Halsey equation (Equation 3.1), the value of equilibrium moisture content was calculated at ambient conditions of temperature at 20ºC and relative humidity at 75% to be 16.53% (d.b) or 14.186% (w.b). The values of the values of K and n used were 7.5335 and 1.1639 respectively from [13] for mushrooms.

$$ERH = \exp\left\{\frac{-K}{Me^{n}}\right\} \tag{3}$$

Where:

ERH= equilibrium relative humidity, decimal
K, n = are constants determined for each material
Me = equilibrium moisture content, percent, dry basis

By drying the mushrooms in the above assumed conditions of temperature and relative humidity, the final moisture content for safe storage is equivalent to the equilibrium moisture content calculated.

Drying results and curves: The drying of the mushroom sample was done at 80 ºC, 60 ºC, 50 ºC, 40 ºC and in direct sunlight. The drying curves are presented in Figure 1.

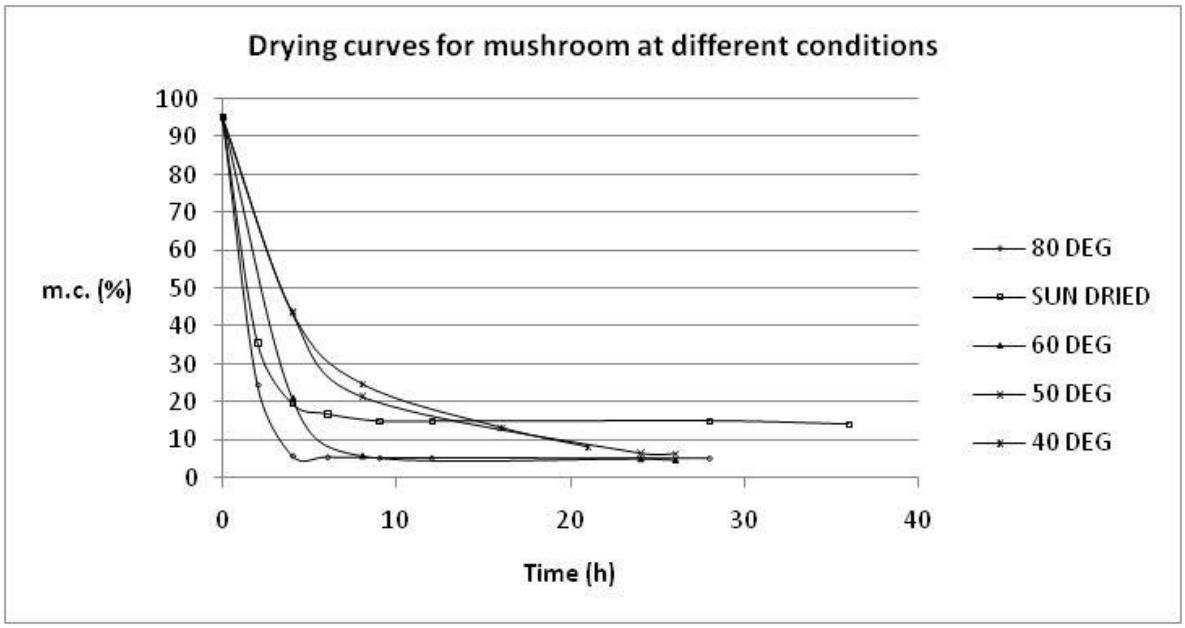

Figure 1: Drying rate of mushroom under different drying conditions

The mushroom dried at 80ºC has the fastest drying rate followed by 60ºC, 50ºC and 40ºC as expected. The mushroom was reduced to safe MC levels below 10% in about 20 hours at temperatures of 30ºC and 40ºC while at drying temperatures of 60ºC and 80ºC this was achieved in under 10 hours. The curve for sun drying did not go below 15% probably because the mushroom attained equilibrium with the surrounding air. Each curve was fitted to the exponential model and the results are presented in Table1.

TABLE 1: Characteristics of the drying trend lines for the mushroom samples

Drying Temp.	Equation of trend line	Coefficient of determination R^2
Sun dried	$Y=15.25e^{-0.15x}$	0.584
40^{O}C	$Y=151.1e^{-1.01x}$	0.867
50^{O}C	$Y=46.64e^{-0.56x}$	0.881
60^{O}C	$Y=20.88e^{-0.41x}$	0.684
80^{O}C	$Y=15.25e^{-0.15x}$	0.408

From Table 1, highest quality of fit is observed by the highest values of R^2. This coincides with samples dried at 40 ^{O}C and 50 ^{O}C with R^2 values of 0.867 and 0.881 respectively. Lowest quality of fit is observed from sample 1and 5 with R^2 values of 0.584 and 0.408 respectively.

Vitamin C content: Equation 2.2 was used to calculate the vitamin C content of each mushroom sample and the results used to plot the curve in Figure 2. The curve indicates a reduction in Vitamin C content from 550.38 mg/100g in fresh mushroom, through 217.8 mg/100g at ambient temperature drying to a low content of 112.52 mg/100g at 105ºC. The reduction is therefore a function of temperature. High temperatures led to a considerable loss in Vitamin C. Exposure to Oxygen is also known to facilitate oxidation of Vitamin C.

However, Fig. 2 shows a change in gradient at 60º C. At this temperature, the Vitamin C reduction rate was found to be higher than the preceding temperatures. This shows that Vitamin C content is highly oxidized at temperatures beyond 60ºc and therefore this was determined as the most suitable drying temperature based on

nutritional analysis. Higher temperatures above 60ºc also caused excess browning and case hardening especially for samples dried at 80ºc and 105ºc.

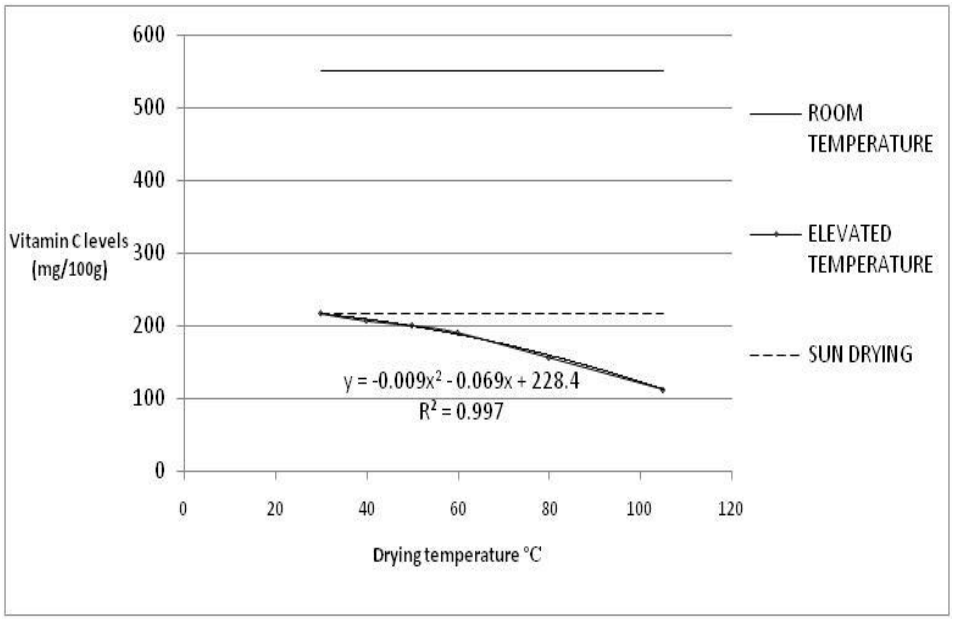

Figure 2: Curve showing Vitamin C levels for the mushroom dried at different temperatures

IV. CONCLUSION

The drying temperature is a very important process variable in vegetable drying and was one of the study area of this project. The findings of this experiment verified that vitamin C is an unstable chemical compound that is degraded when exposed to elevated temperatures. Higher oven drying temperatures would dry a sample faster than lower temperatures but led to nutritional degradation, excess browning and case hardening especially for samples dried at 80ºc and 105ºC. Sun drying rates were found to be higher than those of 40º C and 50º C but weather variations were the major drawback. Therefore, a temperature of 60ºC was found to be the most suitable design temperature for mushroom drying.

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REFERENCES

Journal Papers:

[1] Arora, S., Shivhare, U.S, Ahmed, J. and Raghavan, G.S.V. Drying Kinetics Of Agaricus Bisporus and Pleurotus Florida Mushrooms. *American Society of Agric.*, **2003**. 46 (1) 721-724.

[2] Audrey, M., Audia, B. and Olive-Jean, B. Effect of Processing on Nutrient Content of Foods. *Scientific Research Council*, Jamaica. **2006 37** (1).

[3] Chang, S. T. and J. A. Buswell. 1996. Mushroom nutriceuticals. *www.unapcaem.org* (accessed in October 2016)

[4] Chang, S. T. and P. G. Miles.. Mushrooms: Cultivation, Nutritional Value, Medicinal effect, and Environmental Impact (Second Edition).CRC Press. Boca Raton. **2004**

[5] Krokida, M.K., Karathanos. V.T., Maroulis, Z.B., Marinos-Kouris. D. Drying kinetics of some vegetables **2003**

[6] Lewicki, P.P., Jakubczyk, E.. Effect of hot air temperature on mechanical properties of dried apples. **2004** 36 (1) 81-87

[7] Lukasse, L.J.S.; Polderdijk, J.J., Predictive modelling of post-harvest quality evolution in perishables, applied to mushrooms. *Food Eng.*, **2003**, **59** (1) 191-198.

[8] Manikantan, M.R. Mathematical modeling of drying kinetics of milky mushroom in a fluidized bed dryer **2008**
[9] Method No. 44 of international federation of fruit juice producers, **1972**. Food science
[10] Mizuno T, H. Saito, T. Nishitoba and H. Kawagishi. Antitumour- Active Substances from Mushrooms. *Food Reviews International* **1995**
[11] Mudahar G.S. and Bains G.S. Pretreatment Effect On Quality of Dehydrated *Agaricus Bisporus* Mushroom. *Indian Food Packer* **1982**
[12] Pal, U.S, Chakraverty, A..Thin layer convection-drying of mushrooms. *Energy Convers. Manag.* **1997** 38 (1) 107-113.

Books:
[13] Iglesias, H.A. and Chirfe, J. Handbook of food isotherms: water sorption parameters for food and food components. *Academic Press*, **1982** New York, U.S.A.

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Mbuge D. O., Influence of heat treatment on Vitamin C Levels in Oyster Mushroom. Invention Journal of Research Technology in Engineering & Management (IJRTEM), 2(8), 47-52. Retrieved August 17, 2018, from www.ijrtem.com.